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Can a Northern Arizona Based Small-log Sort Yard Economically Access Current Markets?

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Final Report
Part 1 of 3

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Can a Northern Arizona Based Small-log Sort Yard Economically Access Current Markets?

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Can a Northern Arizona Based Small-log Sort Yard Economically Access Current Markets?

Abstract

This paper examines the economic viability of a regionally located small-log sort yard via a theoretical cost-benefits model. The yard functions as a bridge between a currently marginal small log market to a future condition of regionally located markets well suited to utilize small diameter ponderosa pine logs. The modeled sort yard debarks and air-dries logs from 5" to 10" dbh trees taken from fuels reduction and forest health projects from the Flagstaff urban wildlands. Once processed, these small logs are shipped to the only viable user available at the time of this analysis during the Fall and Summer of 2000 – an OSB plant located in Olathe, Colorado. Larger logs from trees 11" to 15" dbh by-pass the yard. They are shipped directly from the forest to a pallet mill located in Phoenix. Twelve different sort yard scenarios, varying as a function of stand/cut type and sort yard location, were examined. The economic results show that as the quantity of material flowing through the yard increases, sort yard costs decrease. A sort yard located at Garland Prairie vs. Winslow is more profitable because it is closer to the forest resulting in lower transportation costs. The availability of the larger logs is a major factor in predicting economic viability. Sort yards, which process projects that are dominated by excessive quantities of logs from 5" to 8" dbh trees (like the Fort Valley 10K Unit 2 project) will operate at a loss. Sort yards, however, that can access projects that generate larger quantities of logs from the 12" to 15" dbh trees (like the Fort Valley 10K Unit 7 project) will generate profit. The model results also demonstrate that indeed adding value to the small logs through debarking and air drying prior to trucking to market yields more financial benefits than shipping green, unprocessed logs straight from the forest to market.

Introduction

The Greater Flagstaff Forests Partnership, (GFFP), formerly known as the Canyon Forests Partnership, in Flagstaff, AZ, is a collaborative effort between the Coconino National Forest, Grand Canyon Forests Foundation, Northern Arizona University, the City of Flagstaff, and a number of other organizations. The GFFP seeks to reduce the risk of catastrophic fire and restore forest ecosystem health through practices that are ecologically sound, economically viable, and socially acceptable. Its implementation strategy includes thinning of forest stands, introducing low-intensity fires, restoring meadows, and thoughtful minimization of trails and roads.

As the GFFP progresses, the need for a local log sort yard is becoming more urgent. The circumstances of the GFFP are unique, however, in that no current log sort yard exists that is operating under similar conditions. The design of a GFFP log sort yard cannot be modeled off of another log sort yard, but rather presents a new set of challenges and conditions to consider.

The log sort yard traces its origins back to riverbank sort yards associated with the river log drives in New England and the Lake States. Dryland sort yards were first created in the 1960's and have primarily been used by large mills and private middlemen in the Northeast, Northwest, and British Columbia (Dramm, et al., 2001). Today, in northern Arizona, the GFFP has identified the sort yard as one of the better options for dealing with the large quantity of small-diameter logs that are slated for removal from the Flagstaff urban wildlands. By creating a place that can market these small-diameter logs in the most profitable manner, storing the logs until market conditions are optimal and selling them for their most advantageous use, the GFFP hopes to make their projects economically viable in the long term.

The purpose of this study is to assist the development of a GFFP log sort yard by analyzing the complex economics of a regionally-located log sort yard via a theoretical model that accounted for current and projected forest treatment and market conditions. The assumed strategy is that the sort yard will function as bridge to a wood market; economically moving material to the current, less than suitable, market and helping to spur development of regionally-located small wood markets.

Literature Review

A literature review uncovered a great deal of information and research on traditional sort yards – associated with mills or in high log volume regions such as British Columbia – and almost no information on sort yards specifically devoted to small-diameter logs.

Dramm, et al. (2001) recently completed preliminary research summarizing the different possible functions of a sort yard, the possible equipment that may be used, different sorting systems and layout, and key factors for success. Their work aims to identify potential opportunities for small-diameter log sort yards to help diversify rural economies. LeVan-Green and Livingston (2001) explored current uses for small-diameter trees, focusing on small-diameter trees coming out of forest restoration programs in the Interior West. Possible uses include lumber, engineered wood products, structural round wood, wood composites, wood fiber/plastic composites, wood fiber products, pulp chips, compost and mulch, and energy. According to these authors, the potential for these uses is increasing as more forest restoration programs get underway, and the supply of small-diameter wood consequently becomes more stable.

McNeel and Nelson (1991) reported that log size significantly affects processing costs, and that, in general, small-diameter logs (defined in their research as less than 35 ft^3) generate a net loss when processed through conventional log-sorting facilities. Since small-diameter log sort yards do not yet exist, their analysis concentrated on existing sort yards that process large logs, and how small-diameter logs would fare in that market environment.

Tooch (1997) reported on a thriving small sort yard in Vermont whose success largely rests upon its ability to accept both mixed species and uniform loads, along with loads from both small and large operators. This sort yard is geographically affiliated with a mill and financially affiliated with a larger corporation; making its circumstances considerably different than those of the GFFP. Sibal, et al. (1984) completed a study and cost analysis on a potential sort yard in Minnesota, and concluded that a physical sort yard was more productive than a virtual sort yard for a large aspen-sorting operation. Swan (2001) analyzed the complex set of issues and questions surrounding the implementation of a small-diameter

harvest system and sort yard, resulting in a simple, easy-to-read matrix that summarized these issues. Daly (1997) presented an analysis of the different policy issues, market and financial considerations, and complex costs associated with a log sort-yard. A very comprehensive work on log sort yards, and the only published book located, is *A Handbook for Designing, Building and Operating a Log Sortyard* by Sinclair and Wellburn (1984).

The Sort Yard Model

The Log Sort Yard's Function

There are a variety of reasons where a small log sort yard is a logical option. Daly (1997) identifies these as:

1. Supporting stewardship projects and ecological restoration,
2. Increasing access to private woodlots,
3. Encouraging the development of local value-added wood product manufacturers,
4. Filling market gaps or inequities, and increasing the competition with large wood product corporations, and
5. Providing jobs in rural areas.

The function of an envision log sort yard in northern Arizona is a relatively simple one, although all five purposes listed above are all relevant. Given the large quantities of small-diameter logs that could possibly be removed from the Flagstaff urban wildlands, a log sorting facility is necessary to store and market these logs for future sale and utilization. Secondary functions, whose importance will increase once the log sort yard is in place and functioning, include accessing private and state holdings and creating a local market for value-added wood products. The log sort yard will inherently fill a market gap in that no suitable market for small diameter ponderosa pine logs currently exists in the region.

The GFFP has identified a regionally-located log sort yard as a possible strategy to bridge the gap between the potential supply of large volumes of small-diameter logs and the future development of local markets. The sort yard model presented here is used to analyze the potential of this "bridging the gap"

strategy by reflecting current forest and market conditions, while providing a tool for projecting future conditions.

Description of the Log Sort Yard Model

The main features of the sort yard model include a physical sort yard for processing and handling smaller logs from trees 5" to 10" dbh and the direct distribution of larger logs from trees 11" to 15" dbh. The larger logs are sorted at the landing and shipped directly, bypassing the sort yard, to a pallet manufacturer in Phoenix. This user desires a 6" small end, diameter-inside-bark (dib) 16'-6" long log. The sort yard's function relative to these large logs is for brokering and coordination of sales.

The primary function of the modeled sort yard is to serve as a processing center to debark and air dry logs from the smaller trees in preparation for shipment to the only potential user – Louisiana Pacific's orientated strand board (OSB) plant located 410 miles from Flagstaff in Olathe, CO – that can utilize large volumes of the smaller logs. This processing reduces material weight, which enhances trucking economy as more wood can be carried per truck. In addition, the mill will pay more for partially dried wood (Hiner, 2000). The model assumes that all debarked and dried logs are sold to market, and only the bark remains at the sort yard.

The sort yard model consists of a series of linked Excel worksheets. Seven of the eight worksheets are sort yard cost centers. The eighth sheet is a summary worksheet serving to collect data and tabulate profit and loss information. A description of each worksheet is provided below.

Many of the worksheet assumptions vary as a function of the number of treated acres per year or the sort yard location. For the work presented here, the sort yard model was designed around the potential volume of wood coming from three different annual project sizes of 2,000 acres, 5,000 acres, and 10,000 acres:

- The treatment of 2,000 acres per year is a reasonable activity level for the GFFP within its start-up phase.

- The 5,000-acre per year scenario represents a well-established GFFP program within the Flagstaff urban wildlands.
- The 10,000-acre per year scenario is suggestive of a widespread program of forest health and fuels reduction programs beyond the GFFP's focus on the Flagstaff urban wildlands. The sort yard might purchase logs from other sources such as the 14,000 acres of on-the-shelf[1] Coconino National Forest projects (Stephans, 2000) or 25,000 acres of on-the-shelf Kaibab National Forest projects (Holmes, 2000).

Two log sort yard sites were considered: Garland Prairie, AZ and Winslow, AZ; located 31 and 60 miles respectively from Flagstaff, AZ. These two sites had been identified in a land survey conducted by the GFFP as the only realistic opportunities in the region for a possible sort yard. In terms of equipment, labor, and other infrastructure, the two sites were modeled identically. The cost of delivered wood, however, varied considerably reflecting the cost to transport as a function of miles from landing. Transportation costs from the log sort yard to the mill similarly differed for both sites.

Log Inventory Worksheet

This worksheet is used to calculate the pre-sort and sort yard quantities from stand-harvest data. From a user input of the projected number of trees cut per acre within one-inch dbh classes and the number of treated acres, this worksheet calculates the total useable wood in pounds and cubic feet and estimates the amount of bark in pounds generated at the sort yard. This worksheet relies on a variety of assumptions to convert the inputted tree per acre information into useable wood quantities. These assumptions are:

- The taper of the white wood portion of the tree is approximated as a function of tree dbh. For trees 5" to 7", white taper is .13 inches per foot of tree, for 8" to 12" trees, taper is .15 inches per foot, and for trees up to and including the 15" diameter class, taper is .17 inches per foot.
- The outside-the-bark taper from the butt of the tree to 4.5 feet is .5 inches per foot.

[1] These projects have already passed through the NEPA process.

- The log cross-section is composed of 80% white wood by area and 20% bark. The percent of bark vs. the whole log on a weight basis, however, varied as a function of dbh. For trees 5" to 8", the percent by of bark is 14%, for 9" to 11" trees, taper is 12%, and for trees up to and including the 15" diameter class is 10%.
- Bark specific gravity is .39 and white wood specific gravity is .4
- Moisture content of the green wood is a function of bark and white wood moisture content taken as, respectively, 15% and 100%.

Mobile Equipment

This worksheet calculates the annual operating expenses associated with one or more sort yard log loaders for handling (unloading and loading trucks) all available logs from the 5" to 10" dbh trees of the previous log inventory worksheet. Worksheet assumptions include:

- The initial delivered cost for a medium-size, 235-hp loader is $275,000. A sort yard processing logs from 2,000 acres per year would need two of these loaders with a 50% productivity[2] rating.
- A sort yard processing the logs from 5,000 acres per year needs four medium-sized loaders running at an enhanced productivity of 73%.
- The initial delivered cost for a large, 430-hp loader is $550,000. A sort yard processing logs from 10,000 acres per year needs four medium-sized loaders with a 60% productivity rating and one large loader with an 80% productivity rating.
- Yearly depreciation costs are assigned according to a straight-line schedule over a 5-year period with an equipment salvage value of 20% of the initial cost.
- Replacement tire costs for the 235-hp and 430-hp loaders are, respectively, $12,000 and $16,000. Tires are replaced every 4,000 hours of operation for the medium-size loaders and 3,000 hours for the large loader.

[2] Machine productivity is the ratio, expressed as a percentage, of actual number operational hours to scheduled hours.

- An opportunity cost is taken to reflect the loss of investment interest that the money spent towards the initial equipment purchase could have yielded. This cost is 8% of the average value of the yearly investment.
- Taxes are assumed equal to 25% of the yearly depreciation cost.
- Equipment insurance is 1.5% of the yearly depreciation.
- Maintenance and repair costs are estimated at 50% of the yearly depreciation.
- Fuel costs are prorated according to productivity and engine horsepower. Fuel is assumed to cost $1.40 per gallon.
- Additional costs for engine lubricants are approximated at one-third of the fuel costs.
- Schedule hours of operation for the sort yard are 2,000 hours per year.

Fixed Equipment

This worksheet calculates the annual operating expenses associated with non-mobile sort yard equipment including a scale for weighing trucks, log cranes for moving logs around the yard, debarkers, and miscellaneous equipment. Because this worksheet uses many of the same assumptions as that found in the mobile equipment worksheet, only those assumptions that are different are listed below:

- The fixed equipment set for a sort yard processing logs from 2,000 acres of treated forest per year included one $25,000 scale, one $250,000, 485-hp debarker, one $80,000, 150-hp log crane, and $60,000 for miscellaneous equipment. The scale and miscellaneous equipment are assigned a 100% productivity factor and a 10-year service/depreciation life. In contrast, the debarker and log crane are assumed to operate only 40% of the scheduled time with a 5-year depreciation period.
- At 5,000 acres of treated forest per year, the sort yard fixed equipment set is the same as that assumed for 2,000 acres. Log crane and debarker productivity, however, is increased to 100% to account for the larger number of logs being handled and processed.

- It was assumed that a sort yard handling and processing all of the logs from 5" to 10" dbh trees from the annual treatment of 10,000 acres would require two log cranes and two debarkers all operating 85% of the scheduled time. In addition, miscellaneous equipment costs were assumed to double to $120,000.

Buildings

This worksheet accounts for the building costs as well as utilities, ground maintenance, and telephone. These costs are tabulated in Table 1 as a function of the number of annual treated acres. The cost of land was not included in this analysis, due to the difficulties in projecting reliable costs for either site.

Cost of Wood to Sort Yard

This worksheet calculates the cost to harvest all logs, the cost to deliver logs from 5" to 10" dbh trees to the sort yard, and the inventory storage costs associated with air-drying the smaller logs at the sort yard and storage at the landing for the larger logs.

The cost to harvest was taken from previous modeling work over Units 2 and 7 of the Grand Canyon Forests Partnership Fort Valley Research and Demonstration Project (Larson, et al, 2000; Larson and Mirth, 1999). The cost to transport the logs from the landing to the sort yard was based upon $50.00 per hour trucking costs. Incorporating these two variables, the cost of wood to the sort yard from trees 5" to 10" dbh at Garland Prairie and at Winslow were, respectively, $20.60 per ton and $23.84 per ton. The cost to harvest the logs from the larger trees was $15.75 per ton.

Table 1 - Annual Costs Associated with Sort Yard Utilities, Grounds, and Building

	2,000 Acres	5,000 Acres	10,000 Acres
Annual building cost	$60,000	$60,000	$60,000
Building life (years)	20	20	20
Depreciation	$3,000	$3,000	$3,000
Average cost of building	$31,500	$31,500	$31,500
Interest rate	8%	8%	8%
Opportunity cost	$2,520	$2,520	$2,520
Building size (sq. ft.)	400	400	400

Maintenance costs ($/sq.ft.)	$3.00	$3.00	$3.00
Annual maintenance cost	$1,200	$1,200	$1,200
Annual building cost	$6,720	$6,720	$6,720
Annual sort yard utilities	$1,000	$1,500	$2,700
Annual ground maintenance cost	$1,000	$2,500	$4,000
Annual telephone cost	$1,200	$1,900	$3,200
Total annual sort yard site cost	$9,920	$12,620	$16,620

Inventory costs were based upon the cost of delivered wood, the time spent in inventory, and an annual interest rate of 10%. Drying time for logs from the 5" to 10" dbh trees logs was 4 months. It was assumed that the specific weight of the green white wood was 49. 92 lb/ft^3. After drying, the white wood specific weight was reduced to 33 lb/ft^3. Storage of large logs at the landing averaged 1.2 months.

Labor

This worksheet computes total sort yard labor costs per year accounting for hourly wages, benefits, insurance costs, and the number of workers. The number and type of sort yard employees varied with the number of treated acres per year. These workforce assumptions are summarized in Table 2. Labor pay structure and cost to the sort yard per employee type is summarized in Table 3.

Table 2 - Sort Yard Employees as a Function of Annual Treated Acres

	2,000 Acres	5,000 Acres	10,000 Acres
Manager	1	1	1
Equipment Operators	4	6	9
Laborers	2	4	8
Clerk	1	2	2

Table 3 - Sort Yard Employee Costs per Employee Type

	Manager	Equipment Operator	Labor	Clerk
Basic hourly rate ($/hour)	$30.00	$14.00	$10.00	$12.00
Rate for a 40 hour week	$1,200.00	$560.00	$400.00	$480.00
Fringe benefits ($/week)	$384.00	$179.20	$128.00	$153.60
Unemployment compensation ($/week)	$4.71	$4.71	$4.71	$4.71
Workman's compensation ($/week)	$37.92	$17.70	$12.64	$.91
Social Security ($/week)	$91.80	$42.84	$30.60	$36.72
Liability ($/week)	$48.00	$22.30	$16.00	$19.20
Total Cost per Week	$1,766.43	$826.85	$591.95	$695.14
Total Cost per Hour	$44.16	$20.67	$14.80	$17.38

Transportation and Markets

This worksheet calculates the cost to truck logs to various users and the income generated from these sales. As noted earlier, there are only two existing regional markets that can use substantial quantities of small diameter ponderosa pine wood – the OSB mill in Olathe, Colorado for the smaller logs and the pallet mill in Phoenix, Arizona for the larger logs. This model assumes that all logs coming from trees 5" to 10" dbh for the 2,000 and 5,000 acre scenarios are debarked and air-dried prior to shipment to the OSB mill. Trucking costs of $27.49 per ton and $22.50 per ton were developed for, respectively, a Garland Prairie sort yard and a Winslow sort yard assuming that backhauls will be available. It was assumed that the OSB mill would pay, at the mill, $69.50 per ton for the air-dried, debarked logs. All green logs from trees 11" to 15" dbh are shipped directly from the landing to the pallet manufacturer for a trucking cost of $14 per ton. It was assumed that the pallet manufacturer would pay $36.50 per ton of delivered logs.

It is believed, however, that these two markets will become saturated beyond the annual treatment levels of 5,000 acres (Larson, et al, 2001). For the 10,000-acre level, this model anticipates additional markets. The additional small logs are trucked to a potential thermomechanical paper mill to be located in Belen, New Mexico with trucking costs similar to that incurred to Olathe. The price paid for the processed pulpwood, however, will be less. The model incorporated revenue of $57.40 per ton of pulpwood. Although there is currently no readily identifiable new market for the additional large logs, this model assumes that one would develop that was at least economically equivalent to the pallet manufacturer.

Summary

This worksheet tallies and summarizes all relevant sort yard data including annual equipment and infrastructure costs, labor costs, and the cost of delivered wood. The total annual volume of useable wood is calculated along with the amount of bark generated in tons. Income for the wood is projected based upon market and trucking parameters. Profit or loss to the sort yard is estimated.

Analysis of the Physical Sort Yard

Anticipated Log Volumes as Input to the Sort Yard Model

This spreadsheet model is used to analyze the economics of a sort yard located at either Garland Prairie or Winslow for annual forest treatment levels of 2,000 acres, 5,000 acres, and 10,000 acres. The volume of available merchantable material per acre is estimated from log data previously collected on Units 2 and 7 of the Fort Valley Research and Demonstration Project (Larson and Mirth, 1999). These units were treated, using a pre-settlement 2/4 prescription[3] with a 22" cutting cap, by the GFFP between 1999 and 2000. This sort yard analysis, however, limits the size of trees available to less than 16" dbh in recognition of recent GFFP policy on the cutting large trees only under exceptional conditions.

Table 4 - Existing Stand Character of Units 2 and 7 Prior to Treatment by the GFFP

	Unit 2	Unit 7
Total Acres	35.16	36.42
Trees per acre:		
Less than 5" dbh	33.4	333.2
5" to 8" dbh	154.4	54.6
9" to 11" dbh	75.7	60.6
12" to 15" dbh	42.5	60.7
16" to 21" dbh	15.1	51.3
22" dbh and larger	0	3.0
Total Standing Trees per Acre	321.1	563.4

Unit 2 is part of an actively managed forest that had been previously thinned by the Forest Service within the past twenty to thirty years. The existing tree count prior to GFFP's work averaged 321 trees per acre (tpa) with the majority of trees in the 5" to 8" and 9" to 11" dbh classes. Unit 7 is located within the Fort Valley Experimental Forest and, as a result, has not been thinned. The existing tree count prior to GFFP treatment averaged 563.4 tpa with the majority standing trees in the less than 5" dbh class. Table 4 provides a summary of the pre-GFFP-treatment stand character for Units 2 and 7.

Table 5 is a summary of the cutting activity for Units 2 and 7 presented in "% of trees cut per standing trees per acre" and in "ccf/acre". Of importance to this analysis is the large volume of

merchantable wood from the 12" to 15" dbh trees in Unit 7 in comparison to Unit 2. This difference significantly impacts sort yard economics, as discussed in the following section.

Table 5 - GFFP Cutting Activity and Estimated Merchantable Wood Volumes for Units 2 and 7

	Unit 2			Unit 7		
	% cut/standing	# cut/acre	ccf/acre	% cut/standing	# cut/acre	ccf/acre
Less than 5" dbh	100%	33.4	NA	100%	333.2	NA
5" to 8" dbh	94%	145.3	3.79	100%	54.6	1.54
9" to 11" dbh	84%	63.6	4.77	90%	54.5	4.15
12" to 15" dbh	43%	18.2	3.09	65%	39.4	7.04
16" to 21" dbh*	76%	11.4	4.28	46%	23.4	8.29

*This material, although harvested in the original GFFP project, is not included in the sort yard analysis as the GFFP is instituting a large tree policy. This policy will restrict future harvesting to trees that are less than 16" to 18" dbh.

Sort Yard Model Results and Discussion of the Twelve Basic Scenarios

Twelve different sort yard scenarios were analyzed. These scenarios differed by sort yard location (Garland Prairie vs. Winslow), number of acres treated per year (2,000 acres vs. 5,000 acres vs. 10,000 acres), and the nature of the wood available (Unit 2 data vs. Unit 7 data). The results of this analysis are summarized in Table 6.

As the acreage cut per year increased, costs to the sort yard, which includes all harvest and processing related costs, when expressed in terms of log tonnage, correspondingly decreased. Sort yard costs ranged from a high of $30.54 per green ton for the Unit 2, 2,000 acre, Winslow scenario to $15.93 per green ton for the Unit 7, 10,000 acre, Garland Prairie scenario. On a per sort yard site and stand/cut basis, sort yard costs decreased by $6.19 per ton when treatment acres increased from 2,000 acres and to 10,000 acres for the Garland Prairie site processing Unit 7 type material and decreased by $8.05 per ton

[3] For every direct evidence of a dead pre-settlement tree (stump, snag, downed tree, or stump hole), 2 replacement trees are left wherever large (>16 inches d.b.h.), vigorous replacement trees are available within a specified search radius. If the only available replacement trees are smaller than 16 inches d.b.h., four trees are marked for retention.

for similar conditions at the Winslow site. This reflects the well-known economy of scale phenomenon where processing efficiencies increase with larger volumes leading to lower per unit costs.

Transportation costs - trucking large logs from the forest to the pallet mill or trucking the small processed logs from the sort yard to the OSB mill - are critical to the overall economics of the sort yard. The cost to truck small logs from Winslow to the mill is less than trucking from Garland Prairie, because Winslow is about 90 miles closer to the small log markets.

The cost to truck small logs from the forest to the yard, which is included in the costs to the sort yard, however, is the more important variable in predicting overall sort yard economics. Regardless of incoming log inventory and level of treatment activity, the Garland Prairie site shows better overall annual returns than the Winslow site, as it is much closer to the forests of concern to the GFFP. Those trucks transporting smaller logs from the 5" to 10" dbh trees are able to make more and less expensive trips per day to Garland Prairie than to Winslow.

Table 6 - Summary of Log Sort Yard Model Economic Predictions

	Garland Prairie		Winslow	
	Unit 2	Unit 7	Unit 2	Unit 7
Number of Acres per Year	2,000	2,000	2,000	2,000
Tons of Wood Cut per Year	104,941	100,288	104,941	100,288
Sort Yard Costs ($/yr)	-$2,792,054	-$2,218,328	-$3,020,474	-$2,541,347
Cost to Truck to Mill ($/yr)	-$1,586,109	-$1,479,595	-$1,392,549	-$1,479,595
Income from Wood ($/yr)	$4,050,346	$3,805,945	$4,050,346	$3,805,945
Net Income to Yard ($/yr)	-$327,817	$108,021	-$362,677	-$97,376
Number of Acres per Year	5,000	5,000	5,000	5,000
Tons of Wood Cut per Year	262,354	250,720	262,354	250,720
Sort Yard Costs ($/yr)	-$6,358,843	-$4,290,510	-$6,929,898	-$4,634,691
Cost to Truck to Mill ($/yr)	-$3,971,629	-$3,696,424	-$3,487,727	-$3,402,830
Income from Wood ($/yr)	$10,142,435	$9,508,379	$10,142,435	$9,508,379
Net Income to Yard ($/yr)	-$188,037	$1,521,445	-$275,189	$1,470,850
Number of Acres per Year	10,000	10,000	10,000	10,000
Tons of Wood Cut per Year	524,708	501,442	524,708	501,442
Sort Yard Costs ($/yr)	-$12,123,031	-$7,986,364	-$13,260,100	-$8,669,687
Cost to Truck to Mill ($/yr)	-$7,943,258	-$7,392,917	-$6,869,876	-$6,741,660
Income from Wood ($/yr)	$19,102,723	$18,299,243	$19,102,723	$18,299,243
Net Income to Yard ($/yr)	-$963,566	$2,919,961	-$1,027,253	$2,887,895

A Unit 7 stand/cut yields lower wood costs, which in turn benefits sort yard economics. Of the six sort yard scenarios based upon a Unit 7 input log data, five provided a positive net income to the sort yard. Only the Winslow site with a treatment level of 2,000 acres showed a negative return. Unit 2 stand/cuts with a larger percentage of smaller logs always resulted in a loss to the sort yard. The Unit 7 benefits were achieved because of two factors. Although the number of trees harvested in the 5" to 15" dbh class is less on Unit 7 than on Unit 2 (147 tpa vs. 227 tpa), the average volume per harvested tree is more (8.66 cf/tree vs. 5.13 cf/tree). Since fiber volume per tree is the stronger variable in assessing harvesting costs (Hartsough, et al, 1998), Unit 7 yields a cheaper log. In addition to lower harvesting costs, trucking costs were also influenced. Unit 7 produced over two times as many large logs from the 12" to 15" dbh tree class than Unit 2. These logs go directly from the landing, bypassing the incidence of additional processing and handling costs, to the mill that is located about 300 miles closer than the small log mill.

Mixed Input Log Resource Results and Discussion

The above Unit 7 vs. Unit 2 impacts on the twelve sort yard scenarios prompted a follow-on analysis presented here that examined the question:

> Would the balancing of treatments that mixes a limited number of larger trees (e.g. Unit 7) with large numbers of small trees (e.g. Unit 2) enhance sort yard economics?

The analysis consisted of mixing Unit 2 and Unit 7 inputs on a 1,000-acre basis for a Garland Prairie sort yard to examine sort yard results. These results, which are summarized in Table 7, show that mixing as little as 1,000 acres of a Unit 7-type stand/cut in a sort yard processing logs from 5,000 acres per year moves the net income from a loss to a gain. The economics benefits of the additional twenty-one 12" to 15" dbh trees per acre provided by a Unit 7-type stand/cut are significant. Even a marginal market, like

the one analyzed here, provides positive returns for a suitably located small-diameter log sort/processing yard.

Table 7 - Garland Prairie Sort Yard Net Income Summary vs. Log Input Mix

Annual Treatment (Acres)		Net Income $
Unit 2-Type Stand/Cut	Unit 7-Type Stand/Cut	
5,000	0	-$188,037
4,000	1,000	$158,141
3,000	2,000	$499,933
2,000	3,000	$841,725
1,000	4,000	$1,183,517
0	5,000	$1,521,444

Sort Yard Processing Costs vs. Transportation Costs

The sort yard model portrayed here operates as a processing center for debarking and air-drying small logs to add-value to the small log and to minimize trucking costs to the OSB market located 410 miles from the Flagstaff area. It is assumed that the additional yard handling costs are offset by the benefits in more wood fiber per truck (due to lower log weights) and the enhanced price the mill is willing to pay for the processed logs. In this section, we analyze whether or not this premise is valid by comparing the worst sort-yard scenario to the scenario of shipping the small, green logs direct to the mill from the landing.

This comparative analysis requires a close inspection of data obtainable from the individual work sheets for the 2,000-acre, Unit 2-type stand/cut Garland Prairie sort yard scenario. These work sheets provide the following data that is incorporated in a comparative analysis that is summarized in Table 8.

The projected amount of green, unprocessed logs from the available 5" to 10" dbh trees over 2,000 acres of a Unit 2-type stand cut is 68,248.35 tons. After processing, (debarking and air drying to a white wood specific weight of 33 lbs/ft^3), this raw log tonnage is equivalent to 39,103 tons per year. The annual costs to operate the Garland Prairie sort yard include equipment and building costs of $409,762.23, labor cost of $346,280.91, and log storage cost of $46,395.24. In addition, the sort yard incurs the cost to transport the green, unprocessed logs from the forest to the yard for an estimated annual cost of

$328,274.56. Summing, the total sort yard costs equals $1,130,712.94 per year or $28.92/processed ton. As noted earlier in this report, trucking costs from the sort yard at Garland Prairie to the OSB mill was $27.49/ton. Assuming that the landing is 30 miles closer to the mill than the sort yard, trucking straight from the landing to the mill will be slightly cheaper, estimated at $25.74/ton. This analysis also assumes that the mill will pay $69.50/ton delivered for the processed logs and $32/ton delivered for the green, unprocessed logs.

Table 8 - Comparative Analysis: Logs from 5" to 10" dbh Trees of a 2,000-Acre, Unit 2-Type Stand/Cut Processed at a Garland Prairie Sort Yard or Shipped Directly to OSB Mill from Forest

	Logs From Sort Yard to Mill	Green Logs from Forest to Mill
Annual unprocessed logs (tons)	----	68,248.35
Annual processed logs (tons)	39,103.00	----
Annual Yard costs	-$1,130,858.76	----
Annual Trucking costs	-$1,074,941.47	-$1,756,712.53
Annual Mill revenue	$2,717,658.50	$2,183,947.20
Net (Revenue + costs)	$511,858.27	$427,234.67

The results of Table 8 show that the original sort yard premise was indeed a valid one for the conditions of this study. The additional costs of value adding through debarking and air-drying are more than offset by enhanced mill price and reduced trucking costs. Even the worst case sort yard with the highest yard costs provides an additional $82,623.60 of net benefit over the alternative of shipping green, unprocessed logs direct from the forest. All other sort yard scenarios will provide even greater benefits as yard handling costs and/or transportation costs are less than the costs analyzed in Table 8 for the 2,000-acre, Garland Prairie scenario.

Conclusions

Can a northern Arizona based small-log sort yard economically access current markets? Under certain circumstances, a sort yard could provide an appropriate outlet for the large amounts of small-diameter logs coming out of our forests. Serving as a "middleman," the sort yard could add value and sell these logs for their most optimal use at the highest price. And, as shown above, under the right

conditions like mixing 4,000 acres of a Unit 2-type stand/cut with 1,000 acres of a Unit 7-type stand/cut, could generate income for the GFFP.

The establishment and operation of a sort yard is sufficiently complex and expensive that it will require a dedicated management team to continually guide and review the operation. As shown in the earlier analysis, the thinning of forest stands will require careful planning to ensure that an economical mixture of log sizes are being supplied. Wood supplies will have to come from a dispersed geographic area to ensure a consistent supply. Finally, it seems evident that significant subsidies will be needed to support the sort yard for at least the first few years of its operation until the GFFP is treating larger number of acres. Once a consistent wood supply with a good mix of log sizes has been established, the sort yard may be able to support itself.

The net income of various sort yard scenarios under a current market situation that is very marginal has been the main focus of this report. There are, however, other considerations to take into account when deciding if a sort yard fulfills the economic needs of the GFFP. This is especially true in a case like that of the GFFP, where the sort yard would be a collaborative effort between many different interests. Most likely, the visibility of a sort yard can play an important role. A physical sort yard, with a permanent location and more opportunities for marketing and advertisement, may be appealing to investors and potential buyers. This sense of place, coupled with possible room for expansion and growth, is an important element to consider.

The fuels reduction and forest restoration projects of the GFFP are an ongoing effort. If any success is to be achieved by this collaborative process, the question of where the logs will be sent after thinning must be resolved soon. The sort yard model presented here provides a realistic look at one possible solution. It is a solution that bridges the gap between the current situation of a marginal market for small logs, (OSB mill located 410 miles from Flagstaff), to some future desired condition of regionally located markets well suited to utilize the small diameter ponderosa pine logs - the by-product of fuels reduction and forest restoration projects in Northern Arizona.

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Appendix

The following pages are the worksheet output for the sort yard model located at Garland Prairie and processing logs from 2,000 acres of a Unit 2-type stand/cut forest treatment project.